gisticated air," and he endeavoured to explain all his own results as well as the changes occurring in combustion and respiration on the same theory. Thus although in 1774 he prepared oxygen he did not discover it in the true sense of the word, because he failed to understand his discovery. This was reserved for Lavoisier, who, in the year following (1775), published his paper "On the nature of the principle which combines with metals during their calcination," in which he conclusively showed that the principle is taken up from the air, is part of the air. Two years later he demonstrated that the same substance "is the constructive principle of acidity," and he called it the acidifying (or oxygine) principle.

The composition of the atmosphere now became clear; the discovery, or rediscovery, of nitrogen (or *azote*, from its inability to support life) naturally followed, and the gaseous exchanges in the lungs between oxygen from the air and Black's "fixed air," or "aeriform calcic acid," as it was at first termed by Lavoisier, were demonstrated, as we at present understand them. "Thus at a single stroke did this clear-sighted inquirer solve the problem of oxidation, and almost, if not quite, the problem of respiration." This was in 1777.

Three years later Lavoisier and Laplace published their celebrated memoir on heat. In this they definitely state—as the result of measurements of the amount of heat produced by the combustion of a given weight of carbon when burned to carbonic acid, and the amount given out by an animal with the production of a given quantity of carbonic acid—that "respiration is a combustion, slow it is true, but otherwise perfectly similar to the combustion of charcoal. It takes place in the interior of the lung . . . The heat developed by this combustion is communicated to the blood . . . and is distributed over the whole animal system." Later Lavoisier recognised that the combustion of hydrogen, which had been discovered by Cavendish in 1781, takes a part in the production of animal heat. Not until long after Lavoisier—not, in fact, until well into the nineteenth century—was it recognised that the combination of oxygen with carbon and hydrogen occurs, not in the lungs, but in the tissues. Lavoisier was but fifty years old when he was swept away, in 1794, in the maelstrom of the Revolution; all too soon for the science which he had done so much, and in so short a time, to advance.

The tenth and final lecture is devoted to the older doctrines of the nervous system. The views of Vesalius and of Descartes (1596-1650), of Willis (1621-1675) and Glisson (1597-1677), of Borelli, of Stensen (1638-1686) and of Haller (1708-1777) are here set forth, and the history of the doctrine of "irritability" of tissues, first enunciated by Glisson and afterwards by Haller, is described. But, as a matter of fact, the physiology of the nervous system is almost entirely the product of the nineteenth century; before that it can scarcely be said to have a history; everything was obscure, and the place of facts was occupied for the most part by vague speculations.

One of the most prolific subjects of such speculation was the seat of the soul, which was assigned by van Helmont (as we have already seen) to the pit of the stomach, by Descartes to the pineal gland, by Haller, with better reason, to the medulla oblongata. "But we have learned much since Haller's time." . . . "And if he," adds Foster, "with the knowledge and the means at his command, seems to us to-day to have often gone astray, shall not we ourselves one hundred years hence still more often appear to have gone astray?" To which it may perhaps be replied that, although it will always be human to err, yet the means at our command are so much more complete and the methods so much more accurate that it is far less likely that we shall take a start in a wrong direction, or, having taken it, shall continue in it; in this at least we have an advantage over our eighteenth century predecessors, whose methods were, comparatively speaking, rough and their means and opportunities relatively limited.

Whilst endeavouring in the above account to give a general idea of the character of the book with which Sir Michael Foster has enriched the world of science, it is by no means an easy task to do adequate justice to the mine of literary and historic research which the author has laid open to view. But if a perusal of this account serves to induce others to go to the original, we can promise them that they will find it as interesting a story as may be met with for many a long day. And it is to be hoped that the perusal of Sir Michael Foster's history will stimulate the desire of its readers to make the direct acquaintance of the great authors who, during the three centuries under review, laid the foundations of modern physiology and, with it, of the sciences upon which modern physiology is based. E. A. S.

FILTRATION OF WATER.

Water Filtration Works. By James H. Fuertes. Pp. xviii + 283. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1901.) Price 10*s.* 6*d.*

FILTRATION, which is generally regarded as an essential process in the provision of domestic water-supplies for large towns in England, especially when rivers constitute the source of supply, has been neglected to a considerable extent in the United States, and, therefore, the publication of a book, by an American engineer, dealing wholly with this subject, will be particularly valuable if it should lead municipalities in the United States to the more general adoption of this safeguard against the distribution of water to large populations in a condition dangerous to health. Polluted river waters, in their natural condition, have proved very fatal to our troops in South Africa, as shown by the high rate of mortality from enteric or typhoid fever; and the author, at the commencement of his book, draws a very striking contrast between the annual death-rate from typhoid fever per 100,000 persons in cities supplied with pure or filtered water, such as the Hague, Munich, Dresden, and Berlin, with a typhoid death-rate of only from 4·7 to 7, and Washington, Louisville, and Pittsburg, supplied with unfiltered river water, where the yearly typhoid death-rate for several years has averaged 71, 74, and 84, respectively, per hundred thousand of population. River waters are to some extent purified by natural agencies during their downward flow if no fresh causes of contamination are introduced, depending on

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the extent of their original pollution and the length of their uncontaminated flow; and the impurities in suspension may to a considerable extent be removed by causing the water to remain at rest in a settling basin for a certain period before distribution, so that the larger, heavier particles are deposited at the bottom of the basin. Generally, however, after this subsidence has taken place, the finer, lighter particles and micro-organisms remain in suspension in the water, as well as substances in solution; and the final purification can only be effected by filtration, assisted often by aëration, and sometimes by chemical processes.

After an introductory chapter and a chapter on intakes, sedimentation, and settling basins, the author proceeds to the consideration of his main subject, filtration. Two methods of filtration are described for the purification of water-supplies, namely slow sand-filtration, denoted as the English method, from its first introduction and general use in this country, and rapid sand-filtration, requiring the preliminary addition of a chemical solution, termed a coagulant, to render this rapid system efficient, which, being a distinctly American invention, is called the American method. Two chapters are devoted to the consideration of each of these methods in succession, the first in each case discussing the theory, efficiency, and influences of different arrangements and modifications of slow, and of rapid sand-filtration respectively, and the second chapter dealing with the design, construction, and working of slow, and of rapid sand-filters. Following these four principal chapters of the book, is a chapter giving a summary of the relative merits of the two methods of filtration; instances in which a combination of the two methods might be advantageous; and brief descriptions of the Anderson, Pasteur-Chamberland, Worms, and Maignen filtering processes. The book concludes with a chapter on the location, design, and construction of filtered-water reservoirs.

The slow sand-filtration method for the purification of water is well known, and its efficiency has been fully established by long experience in England; and it appears to be the only method, aided by aëration, by which very turbid and polluted river waters, such, for instance, as the waters of the tidal River Húgli, which have to furnish the supplies for Calcutta and Howrah, can be sufficiently purified to serve for a domestic supply. Rapid sand-filtration is a comparatively novel method of purification; and the sand filters for this process consist usually of a layer of coarse grains of quartz sand, 2½ to 3 feet thick, placed in a tank of steel, iron, or wood, from the bottom of which the filtered water is led, through strainers to prevent the escape of the sand, into pipes for conveying away the supply for distribution. Aluminium sulphate has hitherto proved the most suitable coagulant, in which the sulphuric acid enters into combination with the calcium or magnesium carbonate in the water, setting free the aluminium hydrate which forms flocculent masses with the fine suspended matter in the water, and, adhering to the grains of sand as the water passes through the filter, covers them and the bed generally with a gelatinous film, which arrests the bacteria as well as the finest particles in the water, and ensures the efficiency of the filter. When the filter becomes clogged by these impurities, as indicated by a reduction in the flow through it, the bed of sand has to be stirred up and pure water forced up through it to remove the sediment. A rapid flow is less liable to be interrupted by frost; but the proportion of coagulant required in a rapid filter changes with the varying composition of the river water, and necessitates the constant supervision of an experienced chemist to regulate the dose to the conditions, for too small a quantity would reduce the efficiency of the purification, and too large a dose would impregnate the filtered water with alum, and, during the period of low alkalinity in the flood stage of the river, would leave free sulphuric acid in the water, which would be injurious to the pipes.

INTELLIGENCE AS THE SOUL OF THE UNIVERSE.

Modern Natural Theology; With the Testimony of Christian Evidences. By Frederick James Gant, F.R.C.S., &c. Pp. xii+151. (London: Elliot Stock, 1901.) Price 2*s.* 6*d.* net.

IT is no doubt true that the older form of the "argument from design" is more or less discredited by the doctrine of evolution. Nevertheless, the author of the book before us is justified in holding that the argument itself is not disposed of, and that in a setting more strictly accordant with our present knowledge than that which Paley gave it, it is still a powerful weapon in the hands of the natural theologian. More, indeed, is gained under the conception of organic growth than is lost by the sacrifice of the older teleology; for Paley's statement of the case savours of deism, whereas under the more recent view there are distinct indications in the universe of a purpose which may be called moral. In so far as such a purpose is discoverable in nature, to that extent does deism retire into the background. This is the aspect of the matter which is put forcibly, if not very intelligibly, in the work before us. The difficulties inherent in the materialistic as well as the deistic position are, on the whole, well stated, and the way is shown to be open for the recognition of intelligence as the "mind or soul of the universe." Though the author guards himself in words which are capable of an orthodox interpretation, it may be questioned whether the argument from nature, in his way of presenting it, necessarily excludes pantheism. Mr. Gant would probably appeal to the second part of his book—which, dealing as it does more particularly with historical evidences, is somewhat outside our province—as supplying the needful corrective. On the whole, however, it must be allowed that, though his personal convictions are not in doubt, his reading of natural phenomena is more successful as a criticism of the deistic position than as an attack on pantheistic interpretations.

The book would have been better adapted for its purpose if its author had developed his argument in simpler language and with stricter attention to the ordinary rules of composition. Instances of confused diction are numerous; for example:—

> "In all sentient living beings, mind is much moved by suffering for the maintenance, and thence the prolongation of life" (p. 54).

"Thus living beings tell their own story of identifica-

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